FACILITIES FOR PREPARATION OF HIGH EXPLOSIVE AND BOOSTER EXPLOSIVE CHARGES AT NOL (U)

By
Carroll C. Misener

2 SEPTEMBER 1970

NOL
UNITED STATES NAVAL ORDNANCE LABORATORY, WHITE OAK, MARYLAND

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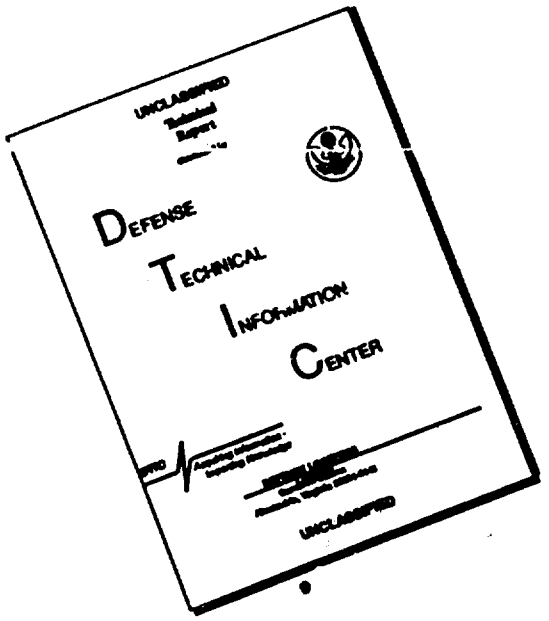

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ABSTRACT: (U) The Chemical Engineering Division, Naval Ordnance Laboratory, has facilities for preparing high explosive and booster explosive charges. Configurations are made to conform to the required dimensions by casting or pressing in a mold directly, or specific needs may require a casting or pressing to be prepared and then machined to the specified dimensions. Due to the dangers accompanying these operations, limitations in quantities and in technique are imposed. Melt cast charges up to 45 kg (100 lb) are made in Bldg 305. Pressing and machining is done in Bldg 318 on charges up to 22 kg (50 lb). Formulation of polymer explosives and propellants is done in Bldg 613. Plastisol cured and chemically cured plastic bonded charges are made in sizes up to 9 kg (20 lb).

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WHITE OAK, MARYLAND

NOLTR 70-152 2 September 1970

Facilities for Preparation of High Explosive and Booster Explosive Charges at NOL (U)

(U) This report supersedes NAVORD Report 6873.

(U) The facilities described in this report are employed for the preparation of a number of charges for the conduct of research and development work on explosives and propellants. Support is derived from tasks in accordance with the need for prepared charges.

(U) These facilities are an essential adjunct to the development and research work in high energy material being carried on at the Laboratory. They must be capable of producing high quality, reproducible charges, even with materials known to be too sensitive for military use. In addition, they must provide safety for the people who operate them.

(U) It should be pointed out that the rules for safety listed herein are based on experience with conventional explosives and that appropriate adjustments should be made with other materials.

GEORGE G. BALL
Captain, USN
Commander

Albert Lightbody
ALBERT LIGHTBODY
By direction

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INTRODUCTION

The studies of the properties of explosives including the effects of explosions require the preparation of high quality explosive charges. Such programs may demand unusual combinations, shapes, and densities of energetic materials. These requirements necessitate specialized facilities and skills where safety as well as control of process are exceedingly important. This report describes the facilities in the Chemical Engineering Division of the Chemistry Research Department for the accomplishment of this work.

Casting - Building 305

In general, any castable high explosive can be cast in the Naval Ordnance Laboratory facility. Three vacuum, steam heated kettles are available (to handle explosive mixtures with melting points up to 100°C) to make charges up to 45.3 kg (100 lb) in weight. The Groen 75.7 liter (20 gal) kettle, Figure 1, has an electric stirrer with speed control. The 30.3 liter (8 gal) kettle also has an electric stirrer, but the 7.6 liter (2 gal) kettle has an air operated stirrer with speed control. Due to safety regulations, explosives having an impact sensitivity of less than 30 cm, as determined on the Bruceton drop test machine, should not be cast.

In special cases, where urgency requires, sensitive materials (such as TNETB), can be cast remotely by using a special set-up in the pressing facility.

Among the explosives frequently cast at Building 305 are: TNT, Pentolite, the HBX's, H-6, Composition B, DINA, EDNA, Cyclotol, Octol, Tritonal and Amatol.

Molds are available for cylinders, spheres, slabs, and bars. Also explosives can be cast directly into warheads or other special containers. Mold sizes are as follows:

Cylinders range from 5.08mm (0.2 in) to 28.6 cm (11.25 in) in diameter and 38.1 mm (1.5 in) to 38.1 cm (15.0 in) long.

Spheres range from 4 g to 45.4 kg (100 lb) weight, based on Pentolite.

Slabs 30.5 cm (12 in) long by 15.24 cm (6 in) wide range from 6.34 mm (1/4 in) to 15.24 cm (6 in) thick.

Square and rectangular bars are made in the slab molds with spacers.

Special molds are available for casting shaped charges 41.3 mm (1 5/8 in) diameter by 15.24 cm (6 in) long, plane wave boosters of

diameters from 41.3 mm (1 5/8 in) to 76.3 mm (3 in), lens charges (donors and acceptors) 10.8 cm (4 1/4 in) diameter by 15.24 cm (6 in) to 25.40 cm (10 in) diameter, and tapered charges 0 to 41.3 mm (1 5/8 in) diameter by 50.8 cm (20 in) long.

Pressing - Hydraulic - Building 318

Two hydraulic presses are available in Building 318. The Farquhar 300 ton double acting compacting press, Figure 2, has 76 cm (30") of daylight between the top ram and the platen. It will provide loads of from 36,287 kg (40 tons) to 272,160 kg (300 tons) on the mold. It has manual or cycle control both directly or remotely. It is equipped with an oil circulating system for heating and cooling the molds, providing temperatures from 10° to 130°C. A vacuum system provides for evacuating the molds. The heating and cooling system and the vacuum system are common to both presses. Molds for this press are available in sizes from 5.08 cm (2 in) to 19.05 cm (7 1/2 in) in diameter. The 12.7 cm (5 in) mold makes possible the widest range of pressures (281.2 to 2109.2 kg/cm² or 4000 to 30,000 psi) thereby providing the widest range of densities in the pressed pellets.

The Watson-Stillman 25 ton single acting compacting press has been modified to provide a bottom ejecting ram. Loads can be accurately obtained from 4,536 kg to 22,680 kg (5 to 25 tons) on the mold. This press is controlled remotely and also connected to the common heating and cooling and vacuum lines. Molds are available in a large variety of sizes from 19.05 mm (0.750 in) to 50.8 mm (2.0 in) in diameter. Special molds available are:

Do-Nut molds 25.40, 27.66, 29.03 and 34.85 mm (1.000, 1.089, 1.143 and 1.372 in) diameters.

With cupped ram or heel 28.45 to 52.58 mm (1.120 to 2.070 in) diameters.

Spherical molds 38.10 to 81.0 mm (1.500 to 3.189 in) diameters.

For booster cups 29.72 mm (1.170 in) diameter.

All booster and secondary explosives can be compacted on these presses including the PBX's. However, under safety regulations, the impact sensitivity limits the size of charges as follows: For pure explosives -

Sensitivity of 10 cm or less - no more than 20 grams

Sensitivity of 11 to 15 cm - no more than 250 grams

Sensitivity of 15 to 22 cm - no more than 450 grams

With metal or abrasive in the compound:

Less than 15 cm - none

15 to 22 cm - no more than 250 grams

These sensitivity values are obtained on the Bruceton type drop test machine using a 2.5 kg weight with the sample on 5/0 sandpaper. This test is described in detail in NAVORD 3592. It is acknowledged that materials whose sensitivity falls in the range below 12 cm are classed as initiators and should be handled with extreme care. However, some of these materials, because of other explosive properties, are considered as high explosives or as boosters. When the pressing of any such very sensitive material is required, consultation is held with the Branch and Division Chiefs and their approval is obtained before the work is begun. In general, it can be stated that it is dangerous to compact on a hydraulic press any material whose sensitivity value falls below 15 cm on the impact scale.

Some explosives (such as RDX), will not make a good pellet, free of cracks and voids, without the addition of a small amount of wax or some other binder.

Pressing - Isostatic - Building 318

The large isostatic press, Figure 3, has a pressure chamber 44.4 cm (17.5 in) diameter x 2.3 m (7 ft) long. The Harwood double acting high pressure pumping system provides pressures up to 2,110 kg/cm^2 (30,000 psi) throughout the chamber. A good variety of flexible molds is available in sizes ranging from 2.5 to 40.6 cm (1-16 in) in diameter of various lengths to 45.7 cm (18 in).

The small isostatic press has a working chamber 18.4 cm (7$\frac{1}{4}$ in) diameter x 1.17 m (46 in) long. It is interconnected to the same pumping system employed by the large press.

All standard explosives have been pressed in the isostatic press. Some explosives such as RDX will not stay together as a pellet after hydraulic pressing. Good pellets can be made by isostatic pressing with the temporary addition of 1 to 2% of solvent (such as acetone) prior to pressing. Because there are no moving metal parts to the molds, danger from friction is minimized, and materials considered too sensitive for hydraulic pressing can be compacted here. While water is being used for the pressure medium the presses may be heated to 100°C making possible the compression and curing of plastic-bonded explosives. By changing the medium to oil, the temperature limit can be increased to at least 130°C.

Machining - Building 318

Any solid explosive with an impact sensitivity higher than 20 cm can be sawed, turned, milled, or drilled at Building 318. The Monarch Model 2013-16 Dyna-Shift air tracer lathe, Figure 4, will swing a 61 cm (24 in) diameter over the ways and 137 cm (54 in) piece between centers. The air tracer provides for turning any desired contour according to a given template. The spindle, and power longitudinal and transverse feeds, can be operated either directly or remotely. This lathe can also be operated conventionally without use of the air tracer. The South Bend Model A Lathe, Figure 5, can swing a 33 cm (13 in) diameter over the ways and 20 cm (8 in) over the cross-slide. It takes a 137 cm (54 in) piece between centers, and may be started and stopped directly or remotely.

Two drill presses are available in this building. The Cincinnati-Bickford drill press, Figure 6, will accommodate work 53 cm (21 in) in diameter x 107 cm (42 in) long below the spindle to the base. The spindle travels 25 cm (10 in) and power feeds vary from 0.102 to 0.508 mm per revolution (.004 to .020 inch per revolution). The spindle speed can be varied from 60 to 1,200 rpm. Starting and stopping can be done directly or remotely.

The Walker-Turner pedestal drill press, Figure 5, also has adjustable automatic feed. Spindle speed can be varied from 400 to 2600 rpm. The distance from the base to the spindle is 91 cm (36 in), the chuck takes drills with shanks up to 12.7 mm (1/2 in) and remote operation is possible.

The Do-All Contour-matic "26" bandsaw, Figure 7, has a throat distance of 66 cm (26 in). It accommodates a work piece 30 cm (12 in) high, and powered table travel is 36 cm (14 in). This machine can be operated either directly or remotely.

All machines are equipped with a means of providing a stream of liquid coolant to the point of contact of the tool and the work. During remote operation there is a 46 cm (18 in) reinforced concrete wall between the operator and the machine. An adequate supply of hand tools, chucks, collets, jigs, and fixtures is kept at hand so that all the usual, and some unusual machine jobs can be done on most types of high explosives.

Mixing, Blending, Drying

On a laboratory scale any explosive or propellant material may be mixed or dry-blended, filtered, dried, pulverized, and screened with available equipment. This equipment includes 1 gal (~ 3-3/4 liters) and 2 gal (~ 7-1/2 liters) Patterson Kelly V-shell blenders, sigma type mixers, kettles, filters, trays, micro-mill, etc. Vacuum drying ovens are shown on Figure 9. Precision weighing equipment shown on Figure 8 enables the operator to make accurate weighings for ingredient requirements, weight loss, and density determination.

Building 615 (Figures 12 and 13) is essentially a 2.44 m (8 ft) diameter steel tube sunk in a hillside. Machining, mixing, and blending of extremely hazardous materials may be done in this facility by remote control.

Inspection and Testing

Very often our technicians are called upon to machine explosives to intricate shapes and tolerances of 0.025 mm (0.001 in).

The Kodak contour projector, Figure 10, enables one to check these shapes very accurately. It has a 76.2 cm (30 in) screen. Table travel is 20.3 cm (8 in) both horizontally and vertically. By use of the micrometer and dial indicator settings, measurements may be made in both directions precisely to 0.0025 mm (0.0001 in). Angles may be measured accurately to 1 minute. Front surface illumination allows measurement to intermediate points (inside the silhouette). There are three magnifications: 10 x, 31-1/4x, and 62-1/2x.

Beside this very valuable machine the inspection equipment includes:

A 61 mm (24 in) square surface plate.

15.2 x 15.2 cm (6 x 6 in) angle plate.

15.2 cm (6 in) sine plate.

Johansson sine bar.

45.7 cm (18 in) Starrett vernier height gauge.

A gun is available in Building 332 for carrying out bullet sensitivity tests in the bombproof Building 331, Figure 11.

Propellant and Explosive Formulation - Building 613

Personnel and equipment are available for research on, and the preparation of solid, composite propellants and explosives.

Equipment for this formulation work includes the following mixers which can be operated remotely and observed through closed circuit television:

3.78 liter (1 gal)	J. H. Day Co., Horizontal (Figure 14)
.95 liter (1 qt) (Figures 15 and 16)	Atlantic Research Corp., Vertical
.47 liter (1 pt) (Figures 17 and 18)	" " " , Horizontal

Mikro Mixer (25-50 g) Atlantic Research Corp., (Figure 19)

All mixers are water jacketed for operations requiring higher than ambient temperatures, and all mixes can be made under vacuum.

The vacuum casting kettle (Figure 20) is approximately 61 cm (2 ft) diameter and 61 cm high.

Slit deaeration equipment (Figure 21) is available for use above the transparent lucite kettle cover. Viscous explosives or propellants are passed through the slits removing the bubbles in the materials and preventing voids in the castings. A rotating table in the kettle allows for remote fast multi-unit casting. Casting pots (Figure 22) are water jacketed and the casting pot valve is capable of remote operation. Pressurized O-ring followers (Figure 23) can be used to push viscous materials through the deaeration tubes into the kettle. An air powered vibrator (Figure 22) can be used to vibrate materials while under vacuum. Electric heating tapes can be used to heat molds while under vacuum (Figure 24). A vacuum manipulator (Figure 25) can be mounted on the lucite cover so that one from outside the kettle can move objects in the kettle without disturbing the vacuum integrity of the system.

A shielded controlled atmosphere box (Figure 26) can be used with rubber gloves or vacuum manipulators for operations requiring dry or inert atmospheres. This box has provision for air, water, inert gases, steam, and electrical outlets. Its explosive limit is 50 grams TNT equivalent.

An armored fume hood (Figure 27 closed, Figure 28 open) is available for hazardous chemical operations. It has steam, water, air, inert gas, and vacuum lines which can be operated remotely. Its explosive limit is 1 lb TNT equivalent. The door, which has two observation windows, can be raised or lowered remotely. The table on the inside can be raised or lowered to accomodate extra tall columns or equipment.

Also available in this facility are two steam heated, drying ovens (Figure 29) and two electric curing ovens (Figures 30 and 31).

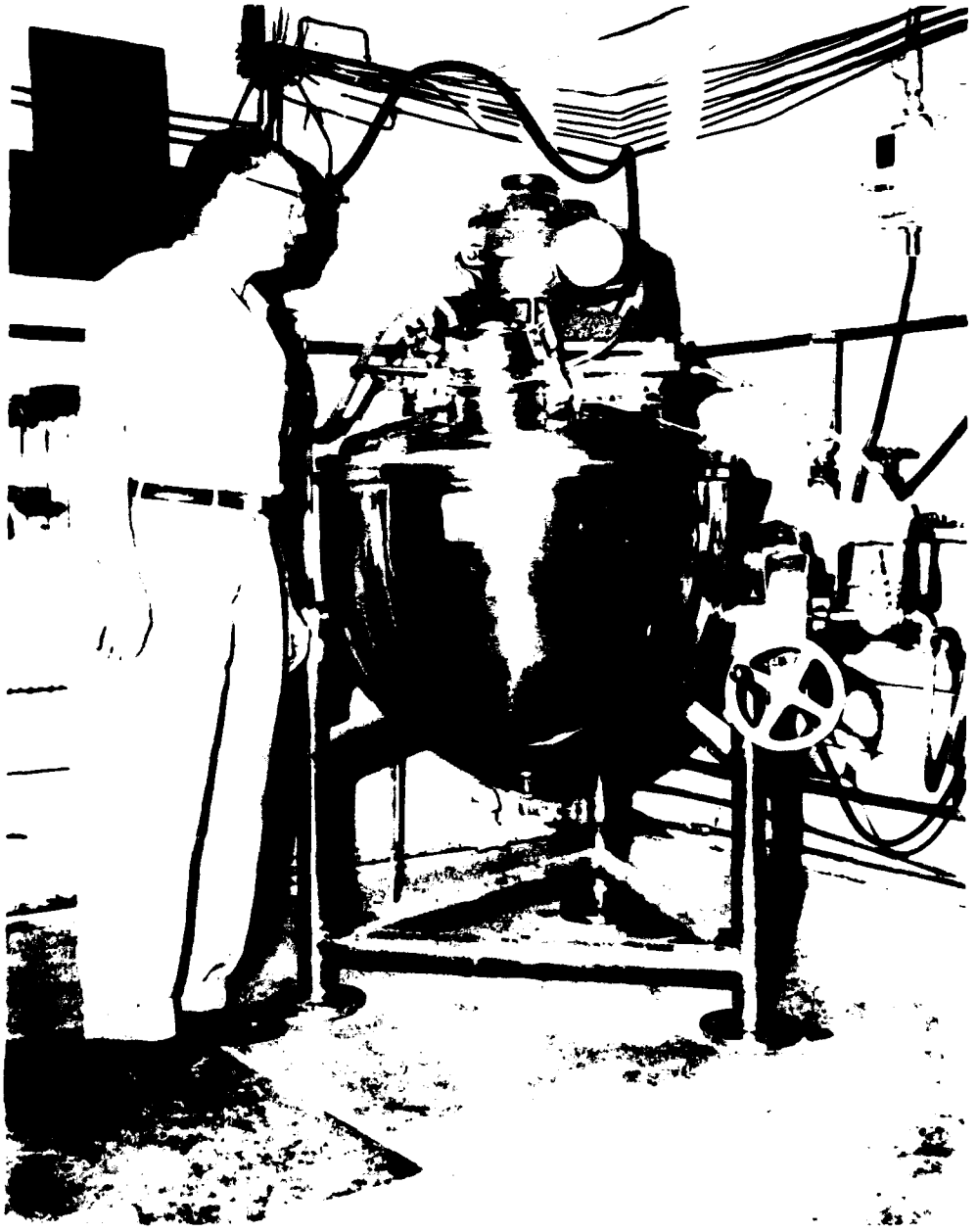


FIG. 1 VACUUM CASTING KETTLE

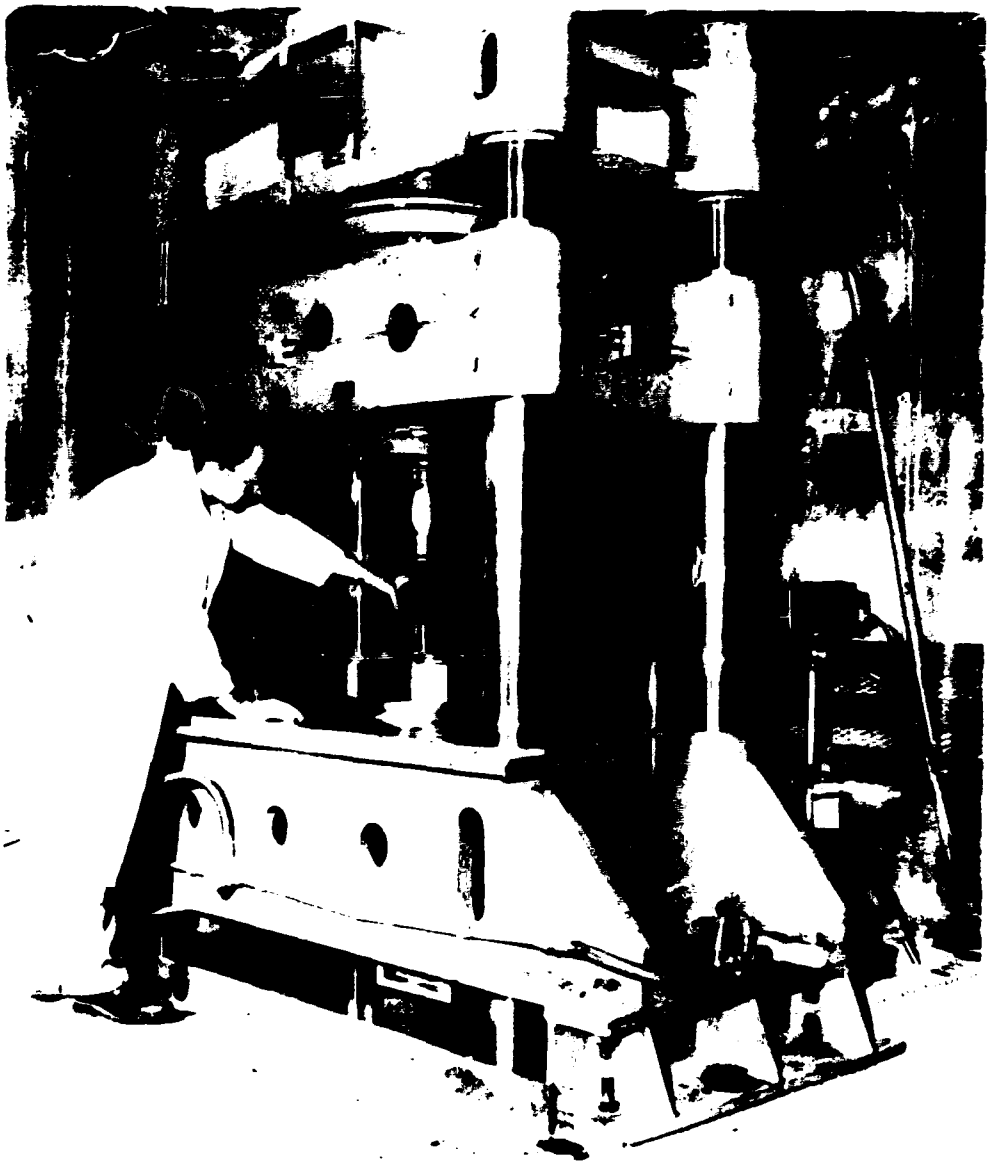


FIG. 2 300 TON HYDRAULIC PRESS

FIG. 3 ISOSTATIC PRESS

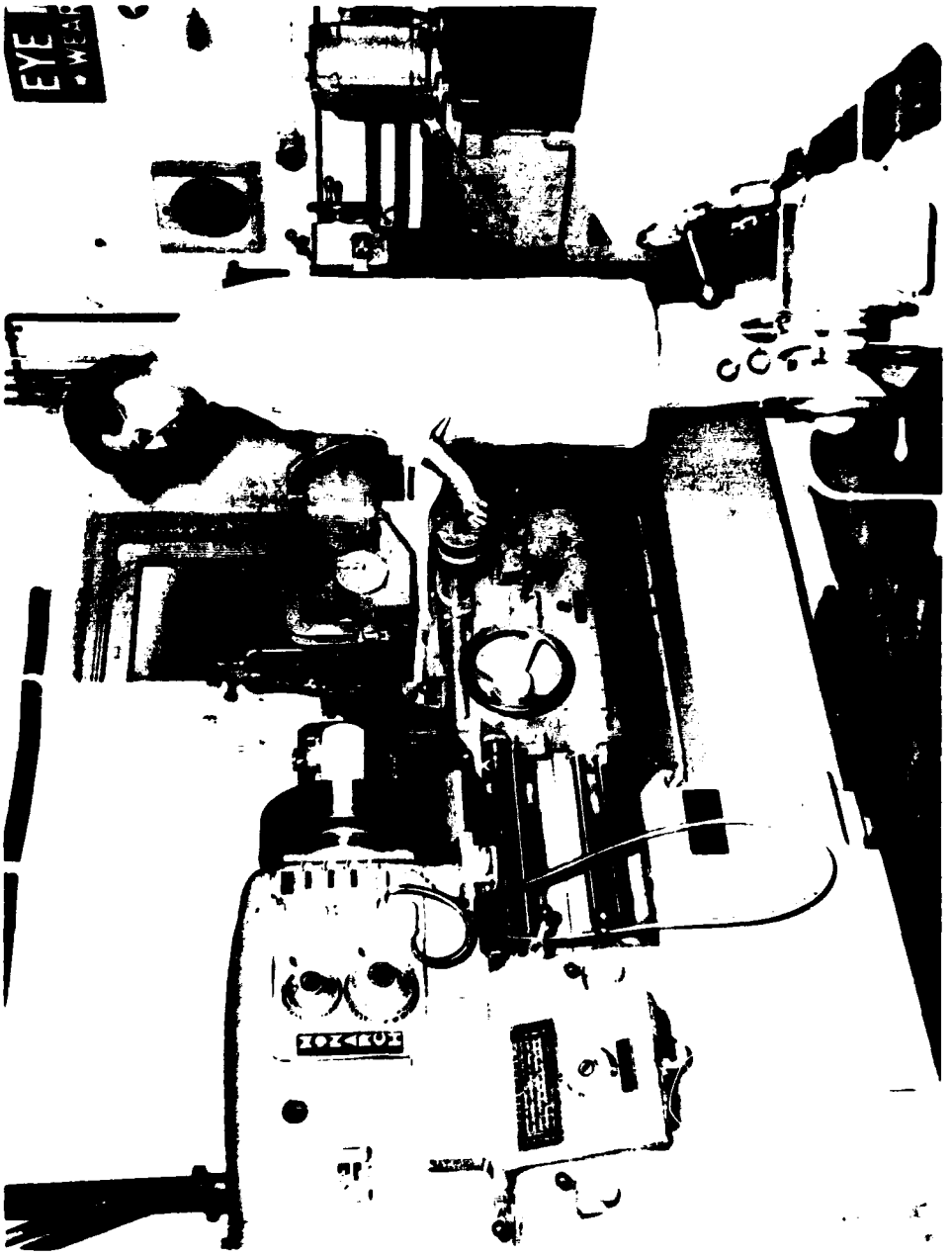


FIG. 4 AIR TRACER LATHE

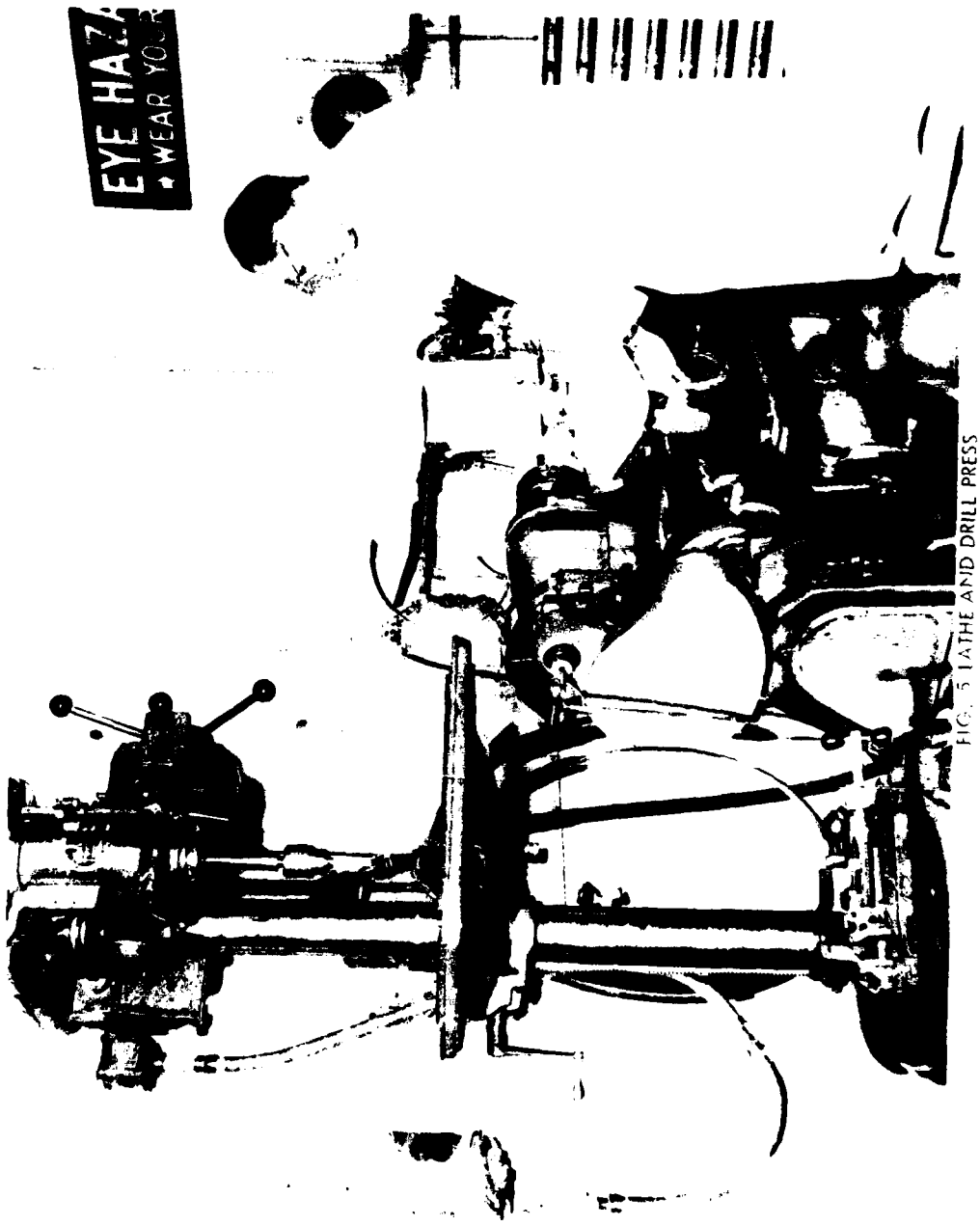


FIG. 5 LATHE AND DRILL PRESS

FIG. 6 DRILL PRESS

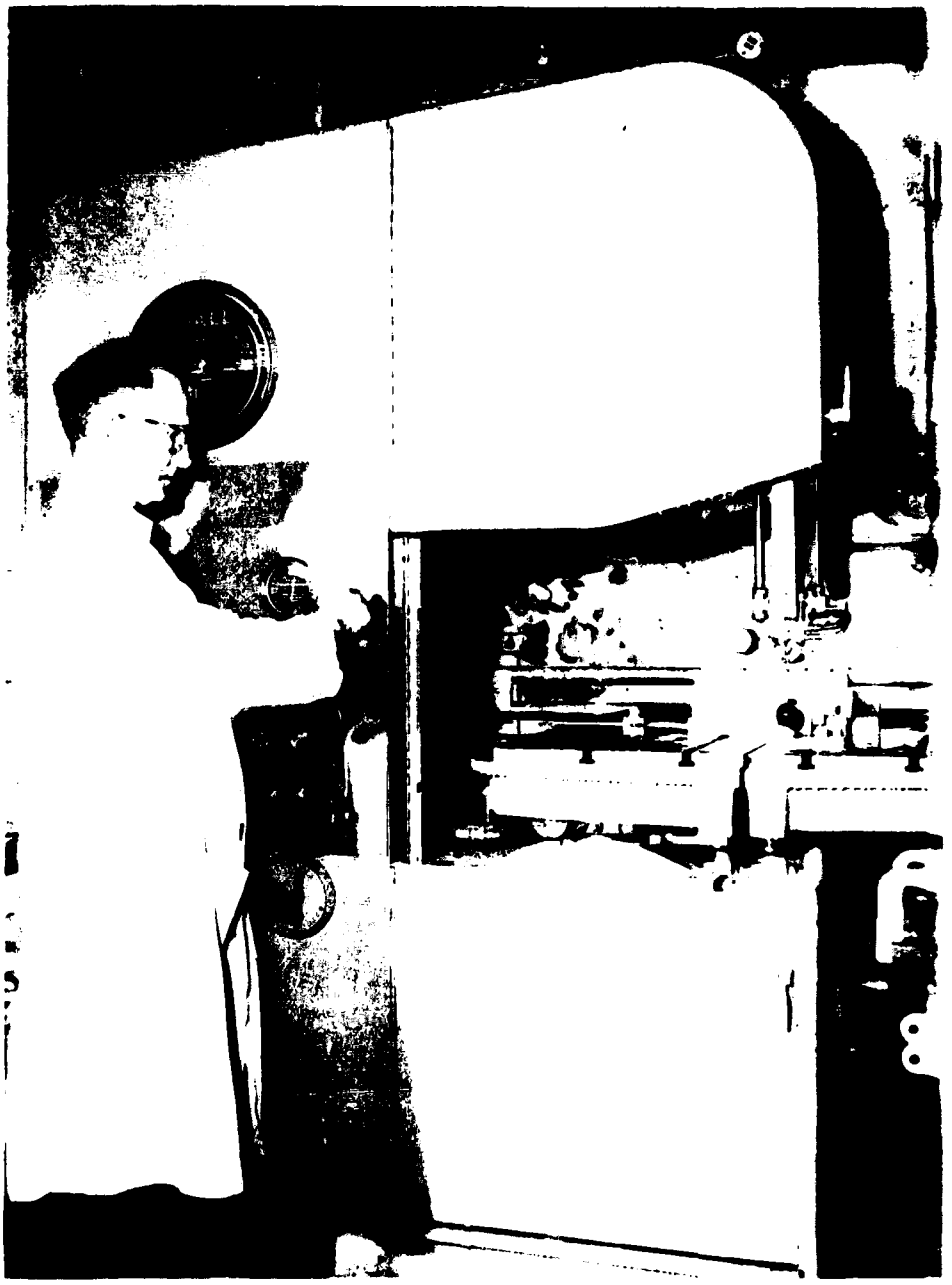


FIG. 7 BANDSAW

FIG. 8 PRECISION WEIGHING EQUIPMENT

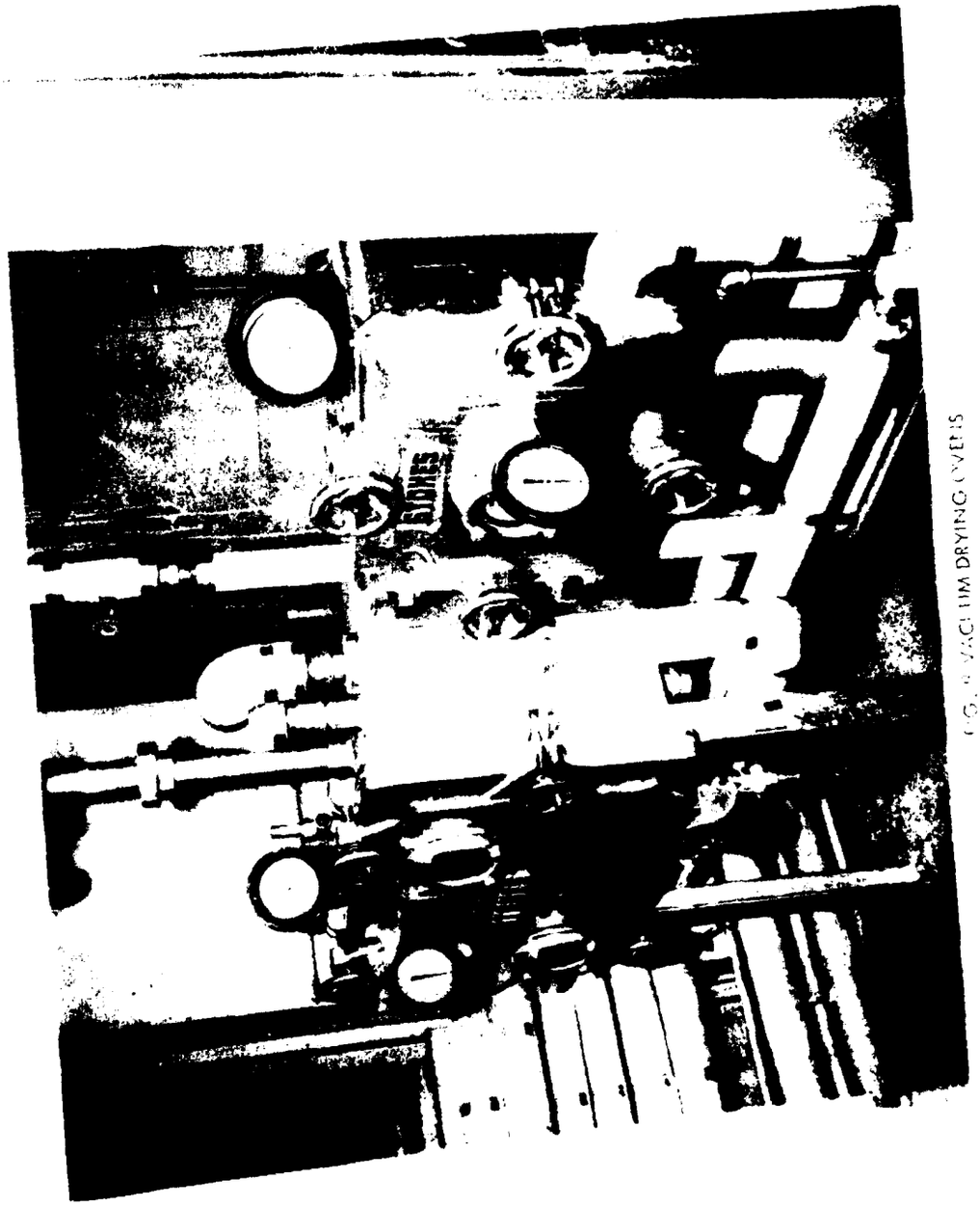


FIG. 4 VACUUM DRYING OVENS

FIG. 10 CONTOUR PROJECTOR

FIG. 11 BOMBPROOF

FIG. 12 BUILDING 615

FIG. 13 BUILDING 615 INSIDE

FIG. 14 ONE-GALLON MIXER

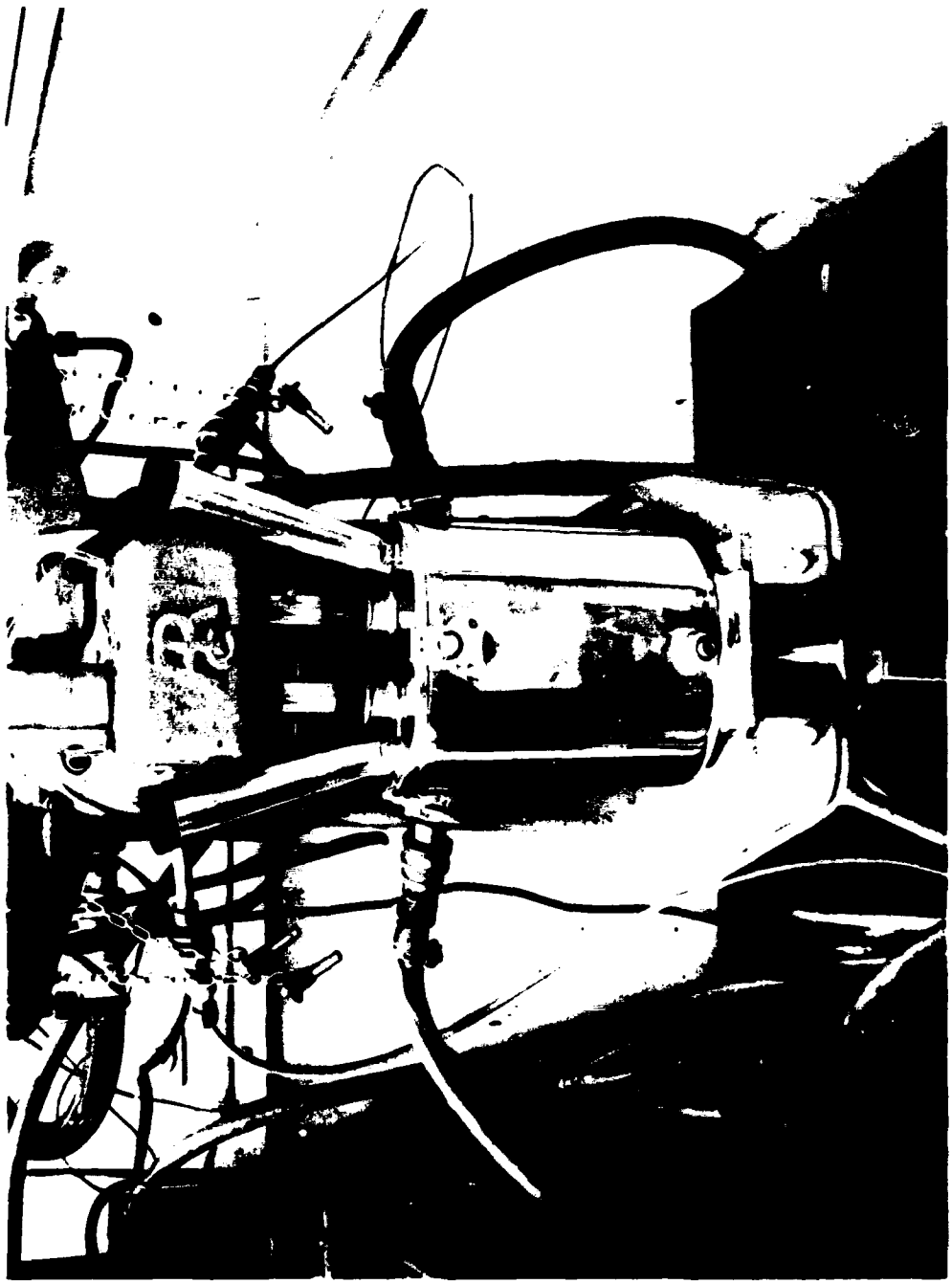


FIG. 15 ONE-QUART MIXER

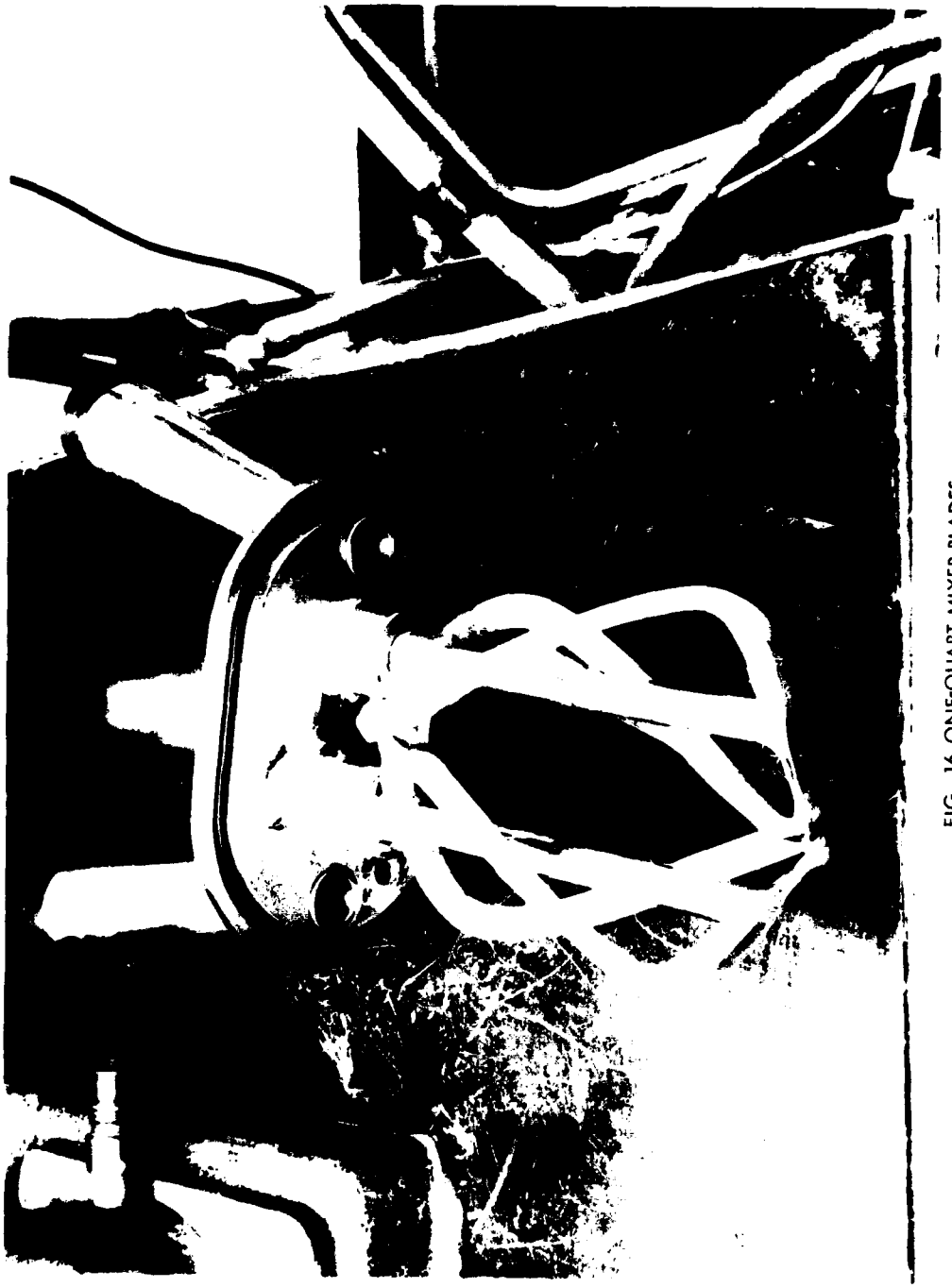


FIG. 16 ONE-QUART MIXER BLADES

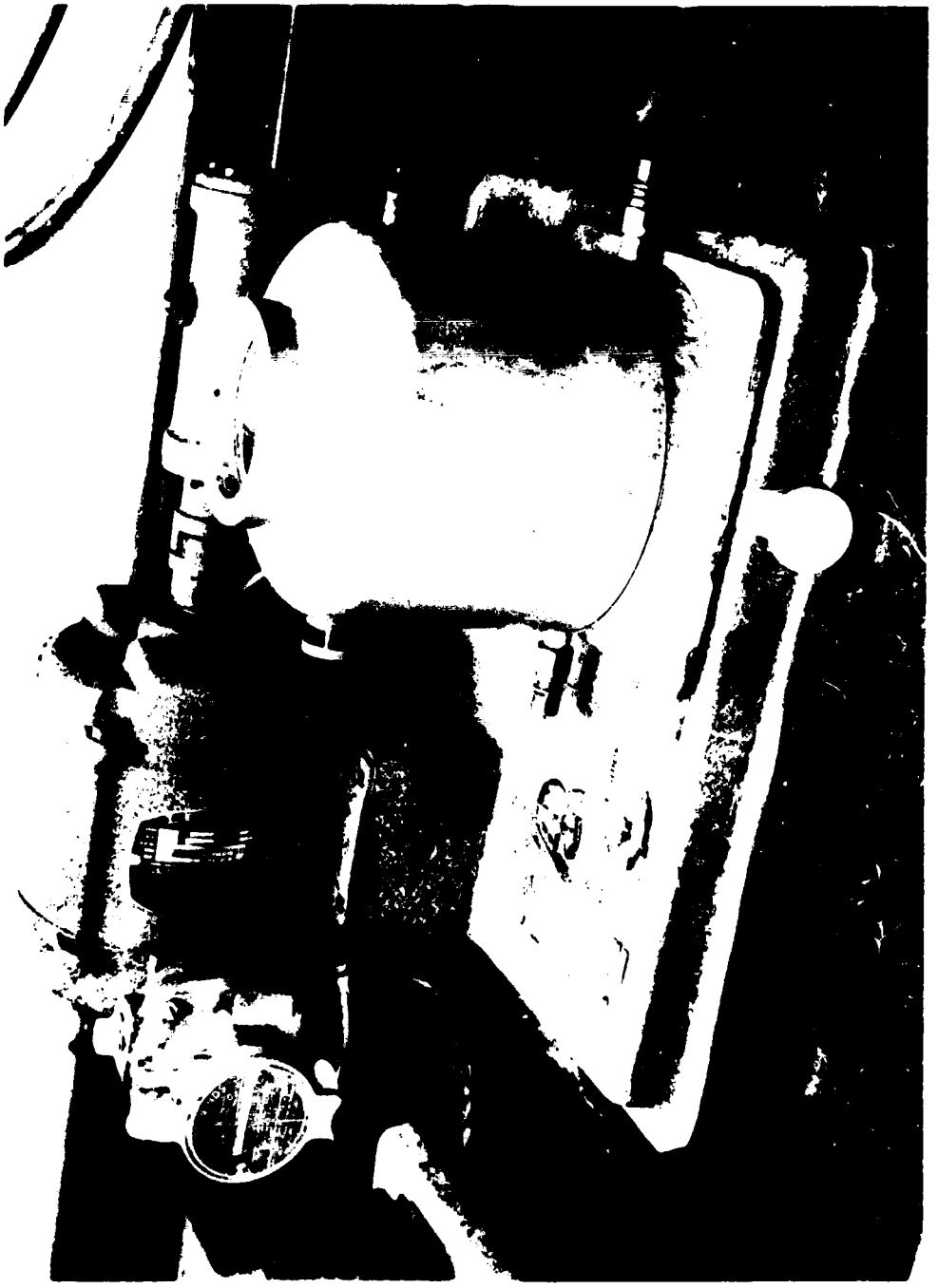


FIG. 1 ONE-PINT MIXER

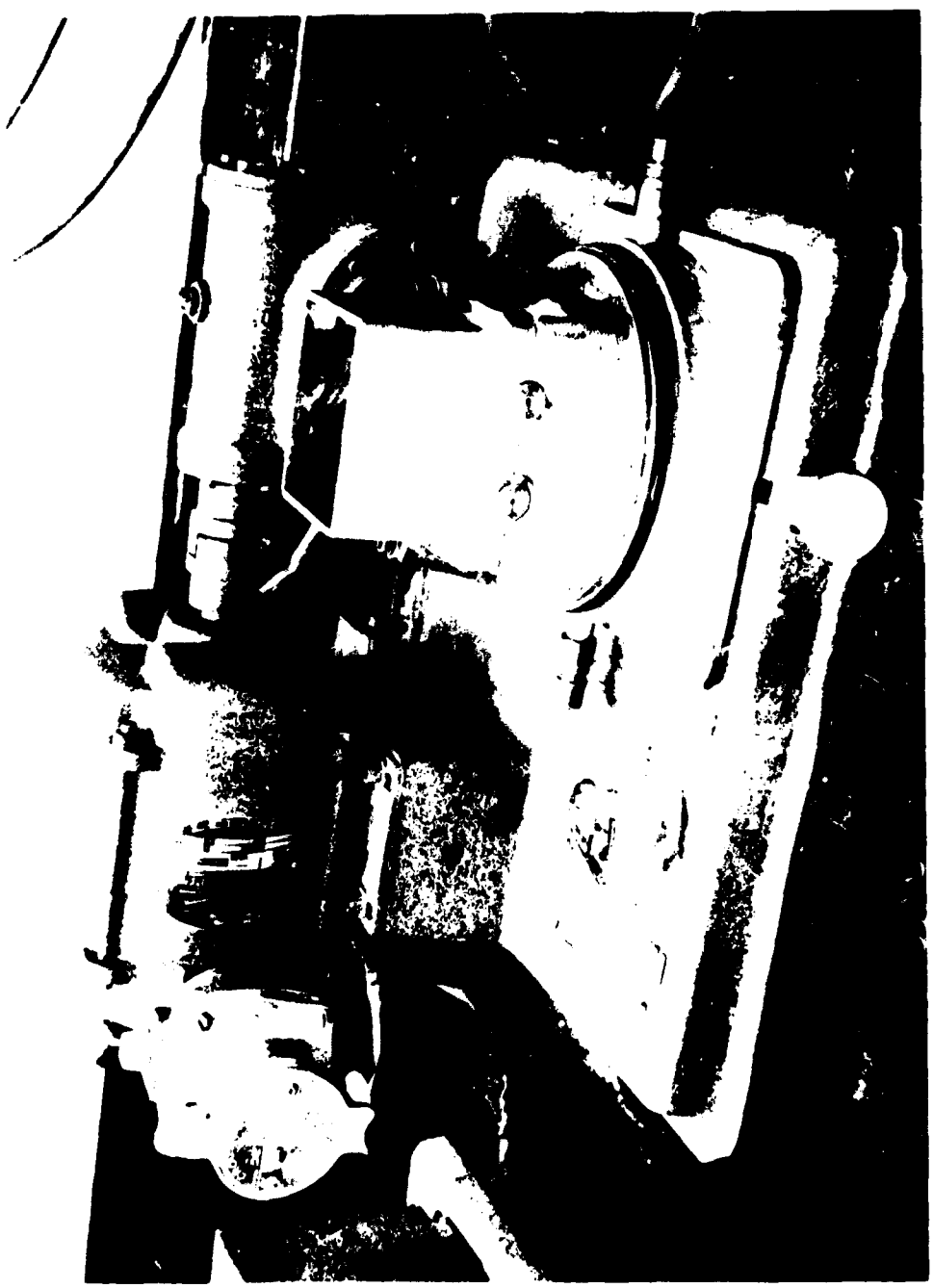


FIG. 18 ONE-PINT MIXER UNCOVERED

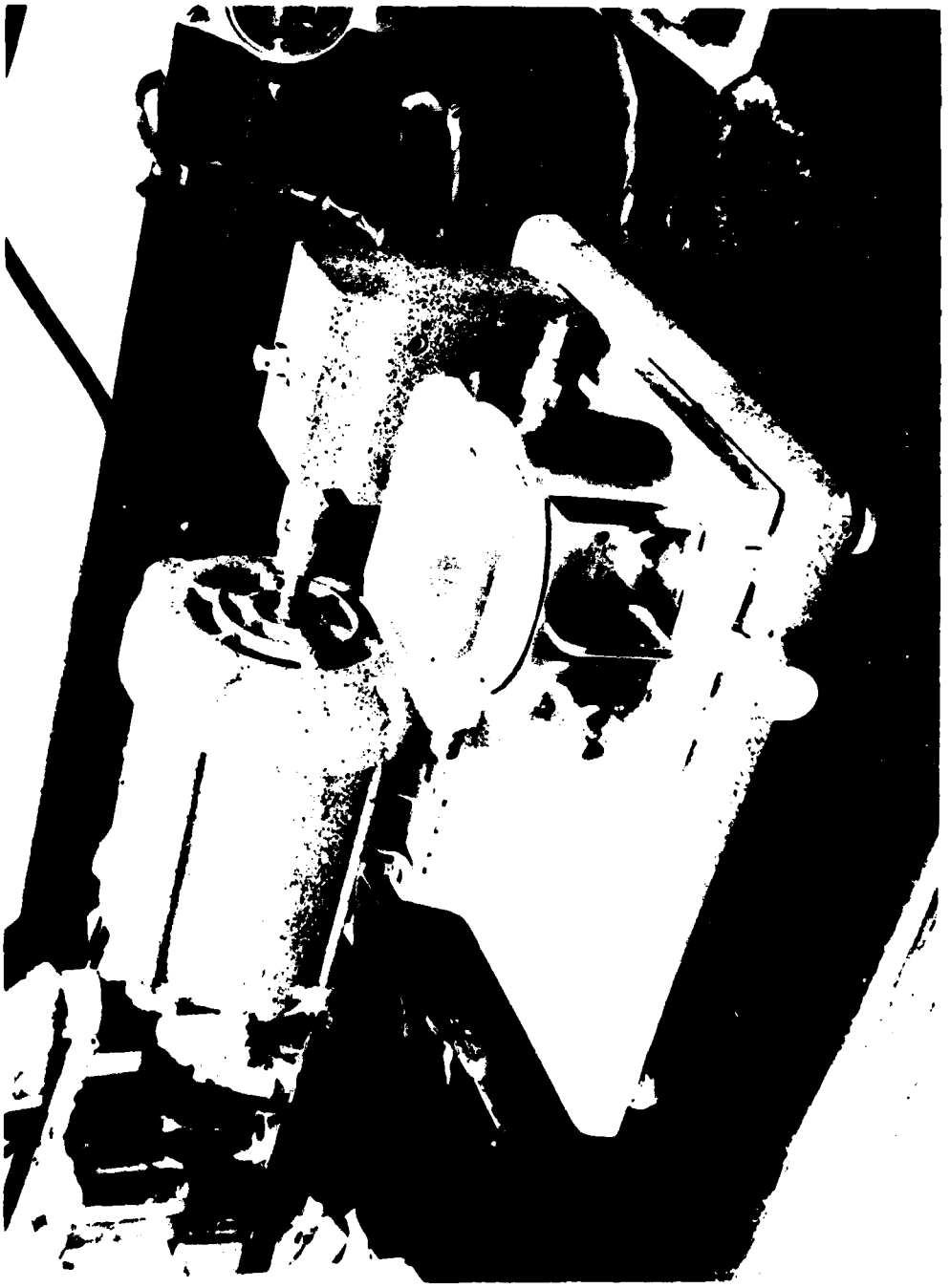


FIG. 19 MIKRO MIXER

FIG. 20 CAST CASTING KETTLE

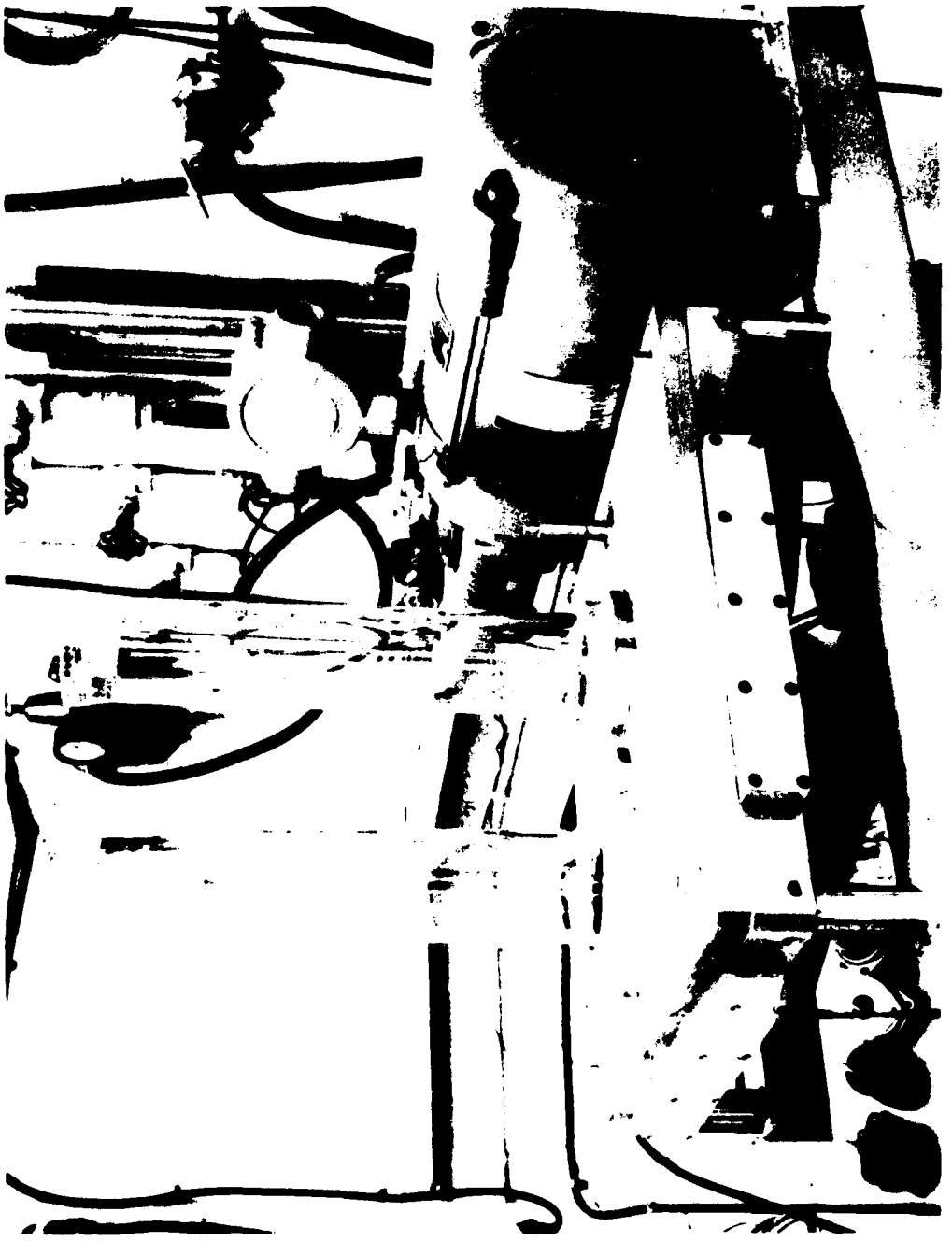


FIG. 21 FABRICATION EQUIPMENT

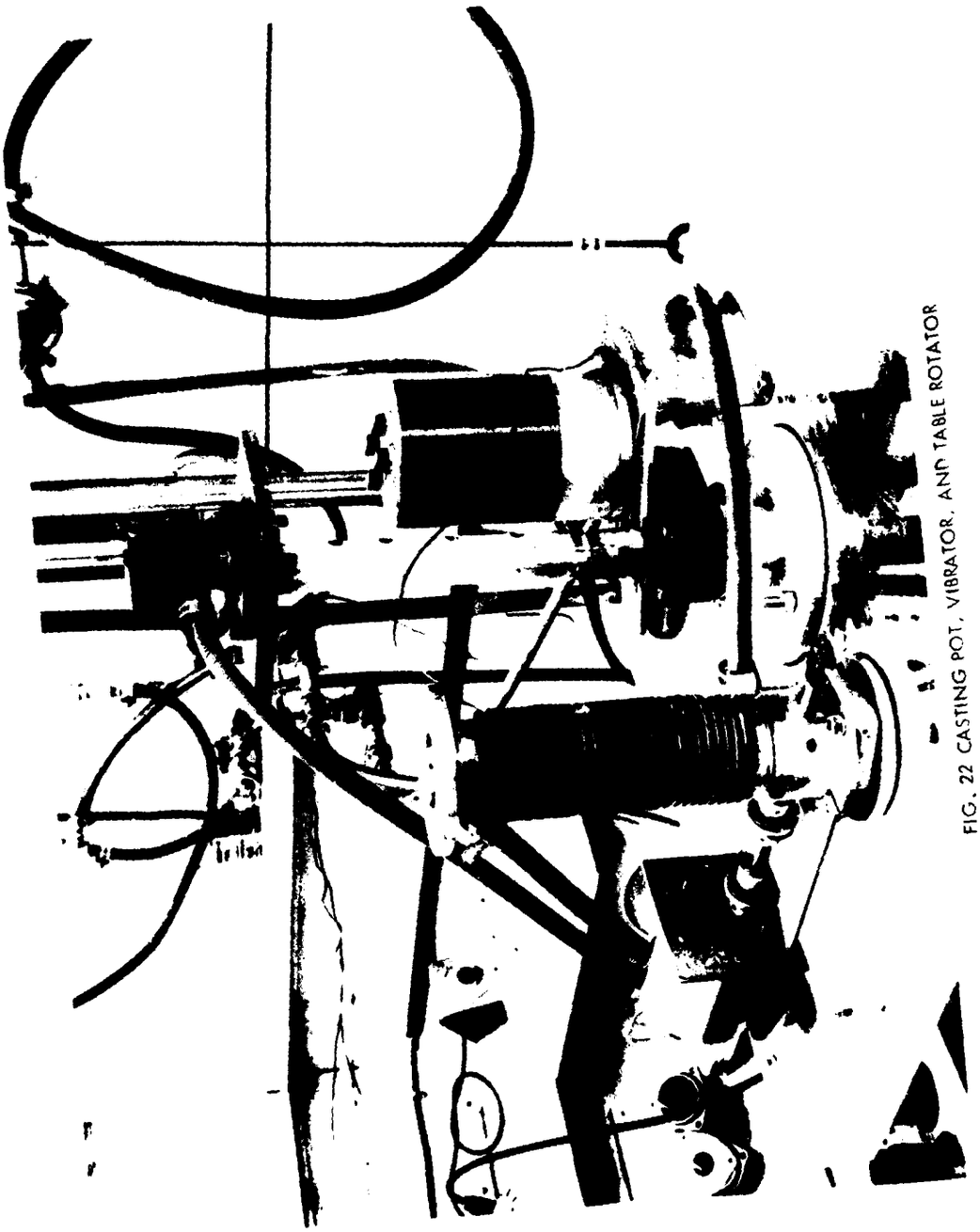


FIG. 22 CASTING POT, VIBRATOR, AND TABLE ROTATOR

FIG. 23 O-RING FOLLOWER

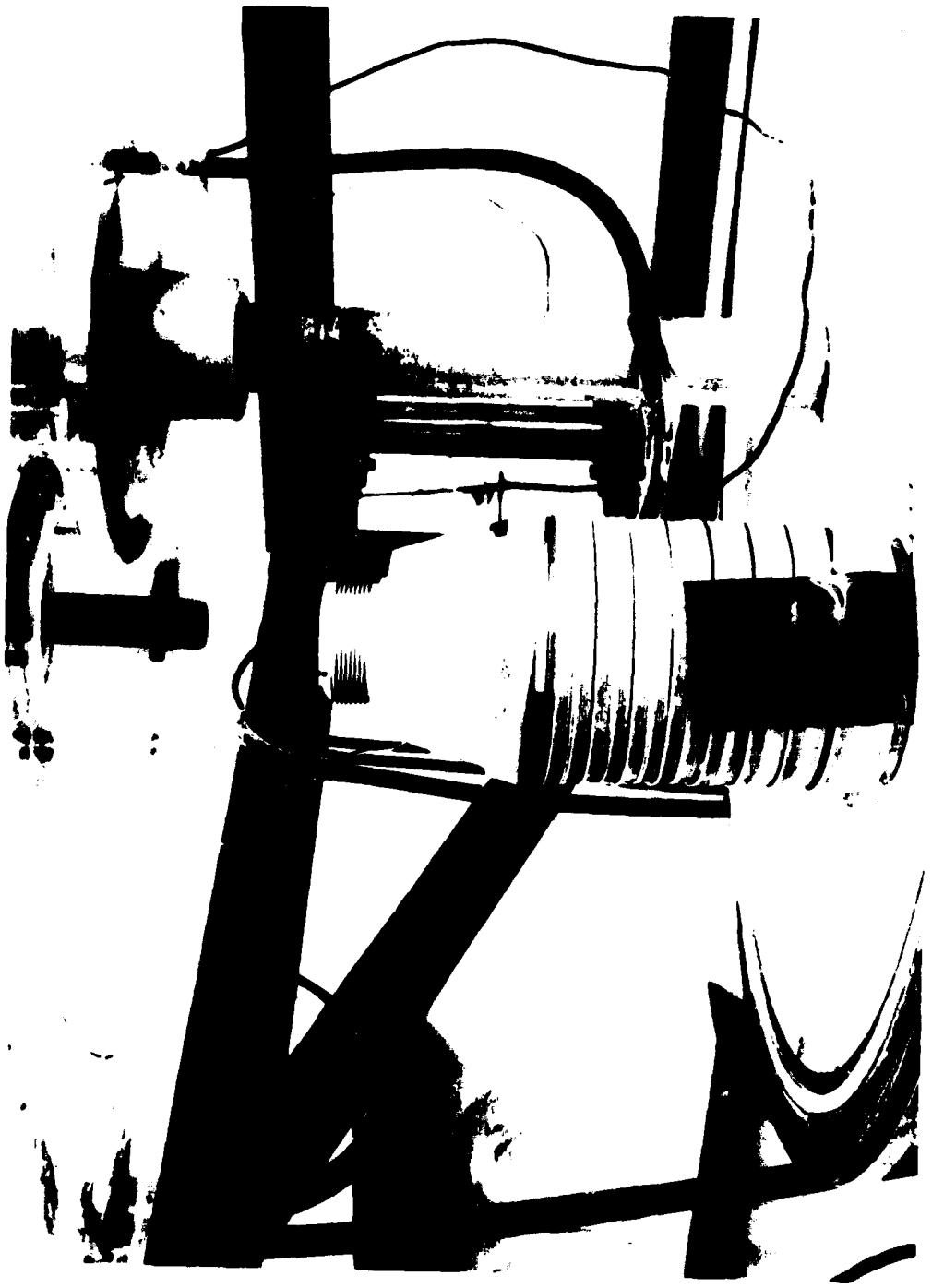


FIG. 24 ELECTRIC HEATING TAPE IN USE

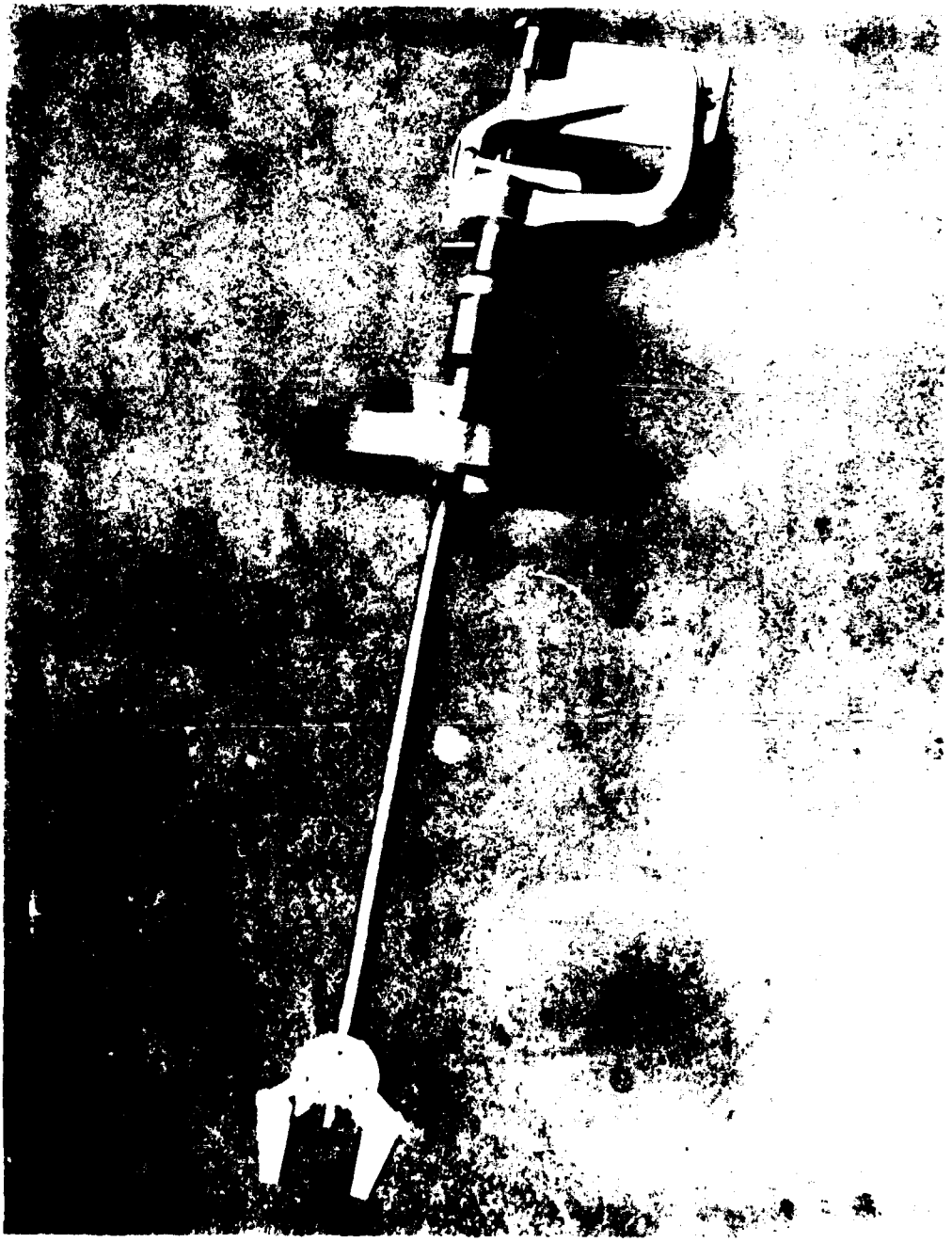


FIG. 25 VACUUM MANIPULATOR

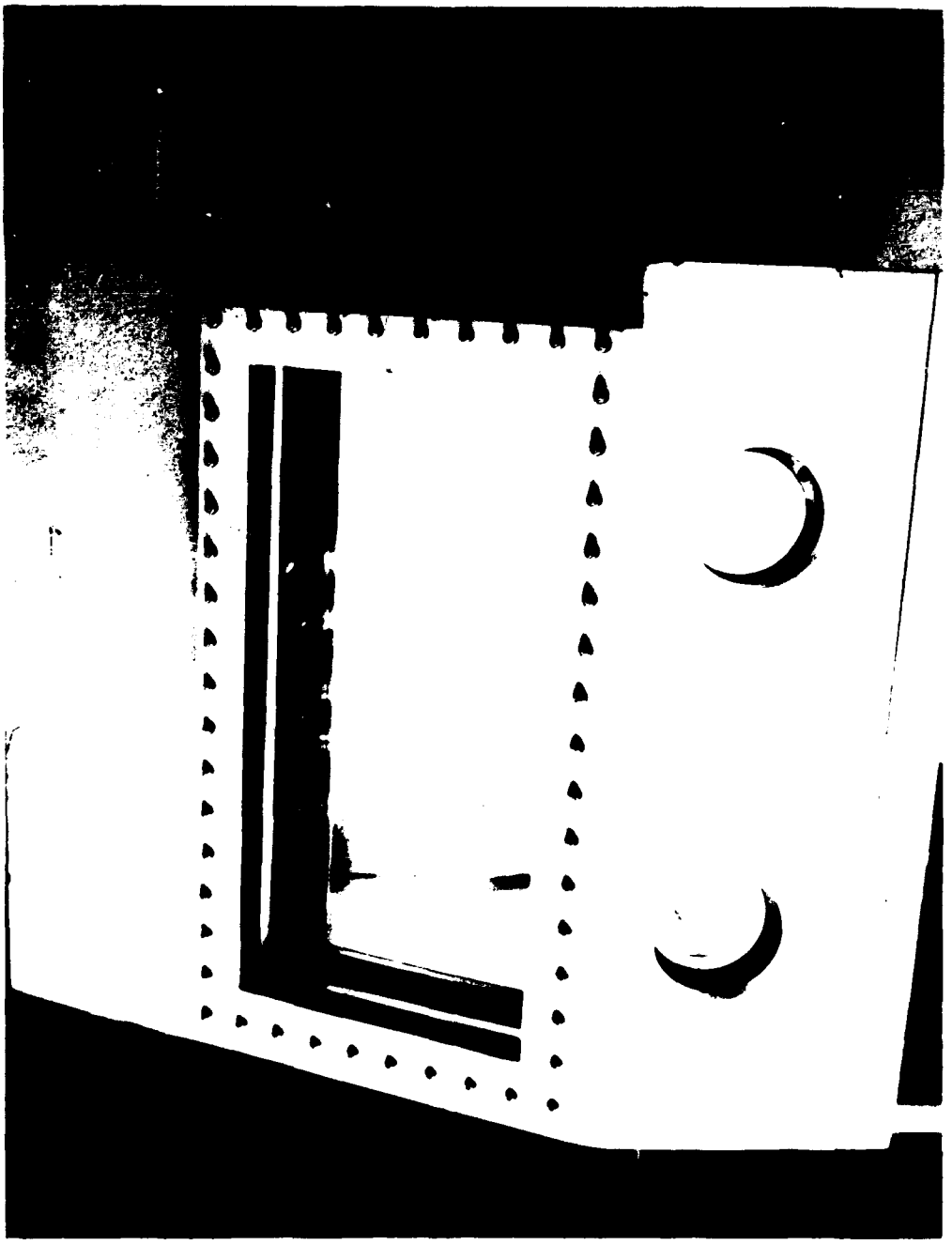
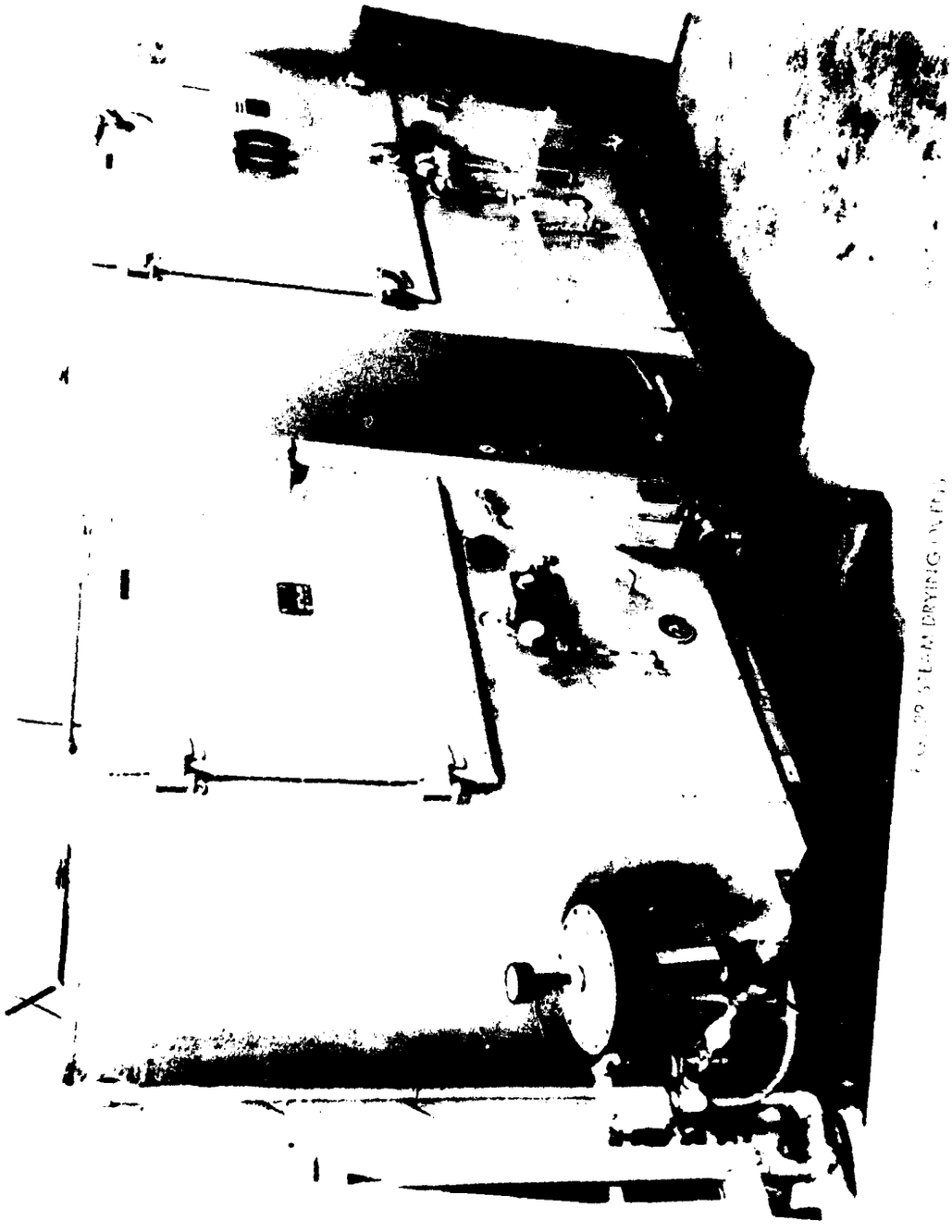


FIG. 26 CONTROLLED ATMOSPHERE BOX

FIG. 27 ARMORED FUME HOOD CLOSED

FIG. 28 ARMORED FUME HOOD OPEN



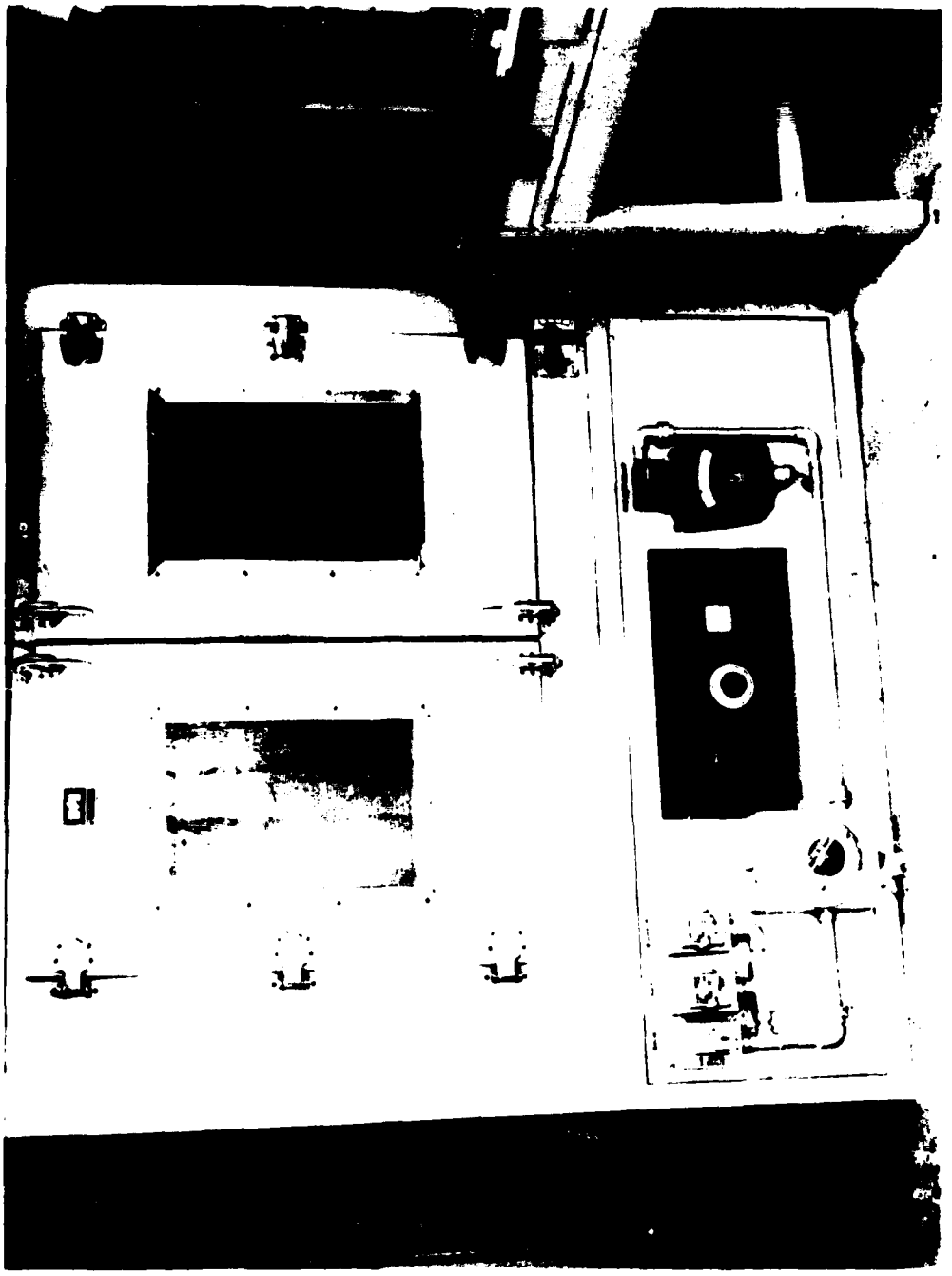


FIG. 30 ELECTRIC CURING OVEN

FIG. 31 ELECTRIC CURING OVEN

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13. ABSTRACT

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14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Explosives						
Facilities						
Formulation						
Casting						
Pressing						
Machining						